By this Amendment, claims 1-7 have been amended, and new claims 8-27 have been added. Therefore, claims 1-27 are now presented for consideration.

No new matter is presented in the foregoing claim amendments and new claims, accordingly, approval and entry of same are submitted to be proper and are respectfully solicited.

OBJECTIONS TO DRAWINGS:

In the Office Action, at page 2, item 1, the Examiner objected to FIG. 1 for not including the legend --Prior Art--.

In the Office Action, at page 2, item 2, the Examiner objected to FIG. 3 because FIG. 3 did not include a reference numeral 200.

A separate letter to the Examiner submitting corrected drawings is attached hereto, which amends FIG. 1 to include the legend --Prior Art—and FIG. 3 to include the reference numeral 200. Therefore, the objections in items 1 and 2 should be overcome. Reconsideration is respectfully requested.

SPECIFICATION CHANGES:

In the Office Action, at page 2, item 3, the Examiner required a new title indicative of the invention.

The title of the invention has been amended as suggested by the Examiner. Reconsideration is respectfully requested.

REJECTION UNDER 35 U.S.C. § 112, SECOND PARAGRAPH:

In the Office Action, at page 3, item 5-6, claims 2-6 were rejected under 35 U.S.C. §112, second paragraph as being indefinite.

Claims 2-6 have been amended to overcome the rejections under 35 U.S.C. §112, second paragraph. Reconsideration is respectfully requested.

ALLOWABLE SUBJECT MATTER:

In the Office Action, at page 5, item 11, claims 3-5 and 7 were indicated to be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. §112, second paragraph and to include all the limitations of the base and any intervening claims.

Reconsideration is respectfully requested.

As above-mentioned, claims 2-6 have been amended to overcome the rejections under 35 U.S.C. §112, second paragraph. Also claims 3, 5 and 7 have been rewritten in independent form, and thus, should now be allowable.

Claim 4, which depends from claim 3, should also be allowable for at least the same reasons as claim 3, as well as for the additional recitations therein.

REJECTION UNDER 35 U.S.C. §102(e):

In the Office Action, at page 4, item 8, claim 1 was rejected under 35 U.S.C. §102(e) as being anticipated by Yang (U.S. Patent No. 6,176,683).

Reconsideration is respectfully requested.

Yang discloses "a collision detection sensor for detecting a vibration at the time when a piston collides with a discharge valve when driving the compressor, a collision detection unit for detecting whether an abnormal signal is generated due to the vibration detected by the collision detection sensor ..." (See Yang at column 2, lines 14-19.) That means that detection by a collision detection unit is based on "the vibration detected by the collision detection sensor."

It is submitted that Yang does not disclose or even suggest "a collision detection unit detecting a collision ... by comparing a peak amplitude of the piston with a preset value" (as recited in claim 1), because the collision detection unit recited in claim 1 compares the peak amplitude of the piston with a preset value, while the Yang collision detection unit is based on vibration detection.

Thus, claim 1 should be allowable for at least the above-mentioned reasons.

Claim 2, which depends from claim 1, should also be allowable for at least the same reasons as claim 1, as well as for the additional recitations therein.

REJECTION UNDER 35 U.S.C. §103(a):

In the Office Action, at pages 4-5, item 10, claim 6 was rejected under 35 U.S.C. §103(a) as being unpatentable over Yang as applied in claim 1.

Reconsideration is respectfully requested.

The Examiner asserts in the Office Action at page 5, line 11-15, that "Yang in Figure 3 and 4 disclose a method of controlling a linear compressor ... b) detecting a signal when the linear compressor operates (SO1, S11, S12 column 5 lines 30-34), c) determining whether any

collision of the piston has occurred on the basis of the detected signal (S02, S13 column 4 lines 49-57)..."

Yang discloses that "the output control apparatus [corresponding to the Yang output control method (see column 3, lines 1-10)] ... includes ... a collision detection sensor 500 for detecting a vibration at the time when the piston collides with the discharge valve during an operation of the compressor, a collision detection unit 600 for detecting an abnormal signal due to the vibration detected by the collision detection sensor 500, a microcomputer 700 for determining a control destination stroke based on the stroke generated by the stroke computation unit 800 when an abnormal signal is detected by the collision detection unit 600." (See Yang at column 3, lines 11-31.) This means that the detected signal, asserted by the Examiner, is the abnormal signal due to the vibration. Thus, comparing the Yang abnormal signal, which is due to the vibration, with a signal corresponding to a preset maximum amplitude would not determine whether any collision of a piston has occurred.

It is submitted that Yang does not disclose or even suggest "determining whether any collision of the piston has occurred by comparing a signal corresponding to a preset maximum amplitude and the detected signal" (as recited in claim 6), because the Yang method cannot produce the method recited in claim 6. This is because a comparison of a signal due to the vibration with a signal corresponding to a preset maximum amplitude would produce an inoperable method.

Thus, claim 6 should be allowable for at least the above-mentioned reasons.

NEW CLAIMS 8-27:

New claims 8-27 are provided to afford a varying scope of protection and are submitted to be allowable for the recitations therein.

CONCLUSION:

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that affect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: 2/14/03

By: Eric Berkowitz
Registration No. 44,030

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE TITLE:

Please **REPLACE** the title of the Invention with the following title:

--APPARATUS AND METHOD FOR CONTROLLING LINEAR COMPRESSOR AND PREVENTING COLLISION OF PISTON--

IN THE SPECIFICATION:

Please **REPLACE** the paragraph staring on page 7, line 7 with the following paragraph:

--The low pass filter 250 has an operation amplifier IC2 whose non-inverting input terminal is connected to an output terminal of the differential amplifying unit 240 through the resistor [R6] R7, and the inverting input terminal is connected to the ground. Further, a resistor R8 and a capacitor C1 are connected in parallel with each other between the non-inverting input terminal and the output terminal of the operational amplifier IC2. --

Please **REPLACE** the paragraph staring on page 7, line 14 with the following paragraph:

--The peak detection unit 260 detects a unidirectional movement of the piston so as to minimize the circuit size, and is provided with a diode D3, a resistor R9, a capacitor C2, and a resistor R10. The diode D3 is connected to the output terminal of the operational amplifier IC2 of the low pass filter 250 to half-wave rectify the output signal from the operational amplifier IC2. The resistor R9 is serially connected between an output terminal of the diode D3 and the control unit 330. The capacitor C2 is connected between the output terminal of the peak detection unit 260 and the ground so as to smooth the output signal from the peak detection unit 260. The resistor R10 is connected between the output terminal of the diode D3 and the ground. --

IN THE CLAIMS:

Claims 1-7 are amended and new claims 8-27 are added.

1. (ONCE AMENDED) An apparatus for controlling a linear compressor with a piston and a valve, comprising:

a collision detection unit [for] detecting a collision of [a] the piston with [a] the valve due to [the] operations of the linear compressor by comparing a peak amplitude of the piston with a preset value;

a control unit [for] determining whether the collision of the piston occurs based on [the basis of] an output signal from the collision detection unit, and resetting maximum amplitude data of the piston of the linear compressor when the collision occurs; and

a compressor driving unit [for] controlling [the] a maximum amplitude of the piston of the linear compressor under [the] a control of the control unit.

2. (ONCE AMENDED) The apparatus according to claim 1, further comprising:

a first storage unit [for] storing preset maximum amplitude data;[,] and

a second storage unit [for] storing [the] reset maximum amplitude data from the control unit, the second storage unit being [embodied as] a non-volatile memory [capable of data reading/writing] to read/write data.

3. (ONCE AMENDED) [The] An apparatus for controlling a linear compressor, comprising:

a collision detection unit detecting a collision of a piston with a valve due to operations of the linear compressor;

a control unit determining whether the collision of the piston occurs based on an output signal from the collision detection unit, and resetting maximum amplitude data of the piston of the linear compressor when the collision occurs; and

a compressor driving unit controlling a maximum amplitude of the piston of the linear compressor under a control of the control unit [according to claim 1],

wherein the collision detection unit includes:

a bridge unit having first and second coils serially connected to a ground, and first and second resistors connected in parallel with the first and second coils and serially connected to each other;

a core [for] linearly reciprocating by penetrating the first and second coils according to a movement of the piston of the linear compressor and made of a magnetic substance;

a sine wave generating unit [for] providing a sine wave to the first resistor and the first coil;

first and second half-wave rectifying units, each [comprised of] comprising a diode[, for] half-wave rectifying an output signal from [the] a junction of the first and second resistors, and an output signal from the junction of the first and second coils, respectively;

a differential amplifying unit [for] differentially amplifying output signals from the first and second half-wave rectifying units;

a low pass filter [for] removing [the] a high frequency component of an output signal from the differential amplifying unit; and

a peak detection unit [for] detecting a peak of an output signal from the low pass filter, and outputting [the] a detected result to the control unit.

4. (ONCE AMENDED) The apparatus according to claim 3, wherein the peak detection unit includes:

a diode [for] half-wave rectifying the output signal from the low pass filter;

a third resistor serially connected to an output terminal of the diode;

a capacitor connected between an output side of the third resistor and [the] ground [for performing] to perform a smoothing operation; and

a fourth resistor connected between the output terminal of the diode and the ground.

5. (ONCE AMENDED) [The] An apparatus for controlling a linear compressor with a core, comprising:

a collision detection unit detecting a collision of a piston with a valve due to operations of the linear compressor;

a control unit determining whether the collision of the piston occurs based on an output signal from the collision detection unit, and resetting maximum amplitude data of the piston of the linear compressor when the collision occurs;

a compressor driving unit controlling a maximum amplitude of the piston of the linear compressor under a control of the control unit;

a differential amplifying unit differentially amplifying output signals according to a detected position of the core; [according to claim 1, further comprising:]

an amplitude calculation unit [for] calculating an amplitude of the piston based on [the basis of the] an output signal from the differential amplifying unit, and providing the calculated amplitude to the control unit; and

a displacement calculation unit [for] calculating a displacement of the piston according to [the] a calculation result from the amplitude calculation unit, and providing the calculated displacement to the control unit.

6. (ONCE AMENDED) A method [for] of controlling a linear compressor, comprising [the steps of]:

[a)] presetting a maximum amplitude by an electronic control of a piston of the linear compressor;

[b)] detecting a signal when the linear compressor operates;

[c)] determining whether any collision of the piston has occurred by comparing a signal corresponding to a preset maximum amplitude and [on the basis of] the detected signal;

[d)] resetting the maximum amplitude if [it is determined that] a collision of the piston [has] is determined to have occurred at [step c)] the determining; and

[e)] driving the linear compressor according to [the] a reset maximum amplitude.

7. (ONCE AMENDED) [The] A method [according to claim 6] of controlling a linear compressor, comprising:

presetting a maximum amplitude by an electronic control of a piston of the linear compressor;

detecting a signal when the linear compressor operates;

determining whether any collision of the piston has occurred based on the detected signal;

resetting the maximum amplitude of the piston if a collision of the piston is determined to have occurred at the determining; and

driving the linear compressor according to a reset maximum amplitude,

wherein the [step d)] resetting of the maximum amplitude includes [the step of] resetting a current maximum amplitude by subtracting the preset maximum amplitude from a previous maximum amplitude[,] so as to prevent the collision of the piston.

8 . (NEW) An apparatus for controlling a linear compressor with a piston and a valve, comprising:

a detection unit detecting a collision of the piston with the valve during operation of the linear compressor according to at least a peak amplitude of the piston;

a control unit determining whether the collision of the piston occurs based on an output signal from the detection unit, and resetting maximum amplitude data of the piston of the linear compressor when the collision occurs; and

a compressor driving unit controlling a maximum amplitude of the piston according to output signals from the control unit.

9. (NEW) The apparatus according to claim 8, further comprising:

first and second storage units to store a preset amplitude value and a reset amplitude value, respectively, when the collision is determined by the control unit.

10. (NEW) The apparatus according to claim 9, wherein at least the second storage unit is a non-volatile memory to read data from and write data to the control unit.

11. (NEW) The apparatus according to claim 8, wherein the detection unit comprises:

a bridge circuit having first and second coils serially connected at respective first terminals of the first and second coils, and first and second resistors connected in parallel with the first and second coils and serially connected to each other at respective first terminals of the first and second resistors;

a core linearly reciprocating by penetrating the first and second coils, a position of the core corresponding to a position of the piston of the linear compressor and magnetically coupling with the first and second coils;

a sine wave generating unit energizing the bridge circuit at second terminals of the first and second coils, respectively;

first and second rectifying units connected to the respective first terminals of the first and second coils and the respective first terminals of the first and second resistors, respectively to rectify output signals thereof;

a differential amplifying unit differentially amplifying output signals from the first and second rectifying units;

a low pass filter removing a high frequency component of an output signal from the differential amplifying unit; and

a peak detection unit detecting a peak of an output signal from the low pass filter, and outputting a detected result to the control unit.

12. (NEW) The apparatus according to claim 8, wherein the detection unit comprises:

a position detection circuit detecting a position of a core by a differential signal provided by first and second coils when the core is linearly reciprocating by penetrating the first and second coils and the first and second coils are excited by an external source;

a low pass filter removing a high frequency component of the differential signal; and

a peak detection unit detecting a peak of the differential signal output from the low pass filter, and outputting a detected result to the control unit.

13. (NEW) The apparatus according to claim 12, wherein the peak detection unit comprises:

a diode rectifying the output signal from the low pass filter;

a resistor serially connected between an output terminal of the diode and an output of the peak detection unit;

a capacitor connected between an output side of the resistor and a first voltage level to smooth the output of the peak detection unit; and

a second resistor connected between the output terminal of the diode and the first voltage level.

14. (NEW) The apparatus according to claim 12, wherein the position detection circuit produces the differential signal proportional to a change in the position of the core by magnetic coupling between the core and each of the first and second coils.

15 . (NEW) The apparatus according to claim 8, wherein the detection unit comprises:

a differential amplifying unit differentially amplifying output signals, the output signals corresponding to a detected position of the piston;

an amplitude calculation unit calculating an amplitude of the piston based on an output signal from the differential amplifying unit, and providing the calculated amplitude to the control unit; and

a displacement calculation unit calculating a displacement of the piston according to a calculation result from the amplitude calculation unit, and providing the calculated displacement to the control unit.

16 . (NEW) The apparatus according to claim 15, wherein the control unit prevents the collision of the piston with the valve, and controls the displacement of the piston and/or amplitude of the piston by results of the detection unit.

17. (NEW) An apparatus for controlling a linear compressor with a piston and a valve, comprising:

a detector to detect a peak amplitude of the piston;

a control unit determining whether a collision of the piston and valve occurs according to the peak amplitude of the piston detected by the detector, and resetting maximum amplitude data of the piston when the collision is determined; and

a driving unit driving the piston according to the detected peak amplitude of the piston.

18. (NEW) A method of controlling a linear compressor, comprising:

setting a maximum amplitude of a piston of the linear compressor;

driving the linear compressor according to a set maximum amplitude;

detecting a signal corresponding to a position of the piston;

determining whether any collision of the piston has occurred by comparing a signal corresponding to a preset maximum amplitude and the detected signal;

resetting the maximum amplitude if the collision of the piston is determined to have occurred at the determining; and

driving the linear compressor according to a reset maximum amplitude to prevent the collision of the piston.

19. (NEW) The method according to claim 18, wherein the resetting of the maximum amplitude comprises:

resetting a current maximum amplitude by subtracting a set maximum amplitude from a previous maximum amplitude so as to prevent the collision of the piston.

20. (NEW) A method of controlling a linear compressor with a piston, a valve and a control unit, comprising:

detecting a collision of the piston with the valve according to at least a peak amplitude of the piston;

determining whether the collision of the piston occurs based on at least the peak amplitude of the piston, and resetting maximum amplitude data of the piston of the linear compressor when the collision occurs; and

controlling a maximum amplitude of the piston according to collision results of the piston.

21. (NEW) The method according to claim 20, further comprising:

storing a set amplitude value by electronic control and a reset amplitude value when the collision is determined.

22. (NEW) The method according to claim 20, wherein the detecting comprises:

detecting a position of a core by a differential signal provided by first and second coils when the core is linearly reciprocating by penetrating the first and second coils and the first and second coils are excited by an external source;

removing a high frequency component of the differential signal;

detecting a peak of the differential signal after the high frequency component is removed; and

outputting a detected result to the control unit.

23. (NEW) The method according to claim 22, wherein the detecting of the peak comprises:

rectifying the differential signal after the high frequency component is removed; and

smoothing the rectified differential signal.

24. (NEW) The method according to claim 22, wherein the detecting produces the differential signal proportional to a change in the position of the core by a magnetic coupling between the core and each of the first and second coils.

25. (NEW) The method according to claim 24, wherein the detecting comprises:

differentially amplifying output signals according to a detected position of the core;

calculating an amplitude of the piston based on the differentially amplified output signals;

calculating a displacement of the piston according to the calculating of the amplitude; and

outputting the calculated amplitude and the calculated displacement.

26 . (NEW) The method according to claim 25, further comprising:

preventing the collision of the piston with the valve by controlling the displacement of the piston and/or the amplitude of the piston by results of the detecting of the position of the core.

27. (NEW) A method of controlling a linear compressor with a piston and a valve, comprising:

setting a maximum amplitude value of the piston;

detecting a peak amplitude of the piston;

determining whether a collision of the piston and the valve occurs according to the detected peak amplitude of the piston; and

resetting a maximum amplitude value of the piston when the collision is determined; and

driving the piston according to the collision results of the piston.

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FIG. 1
(Prior Art)

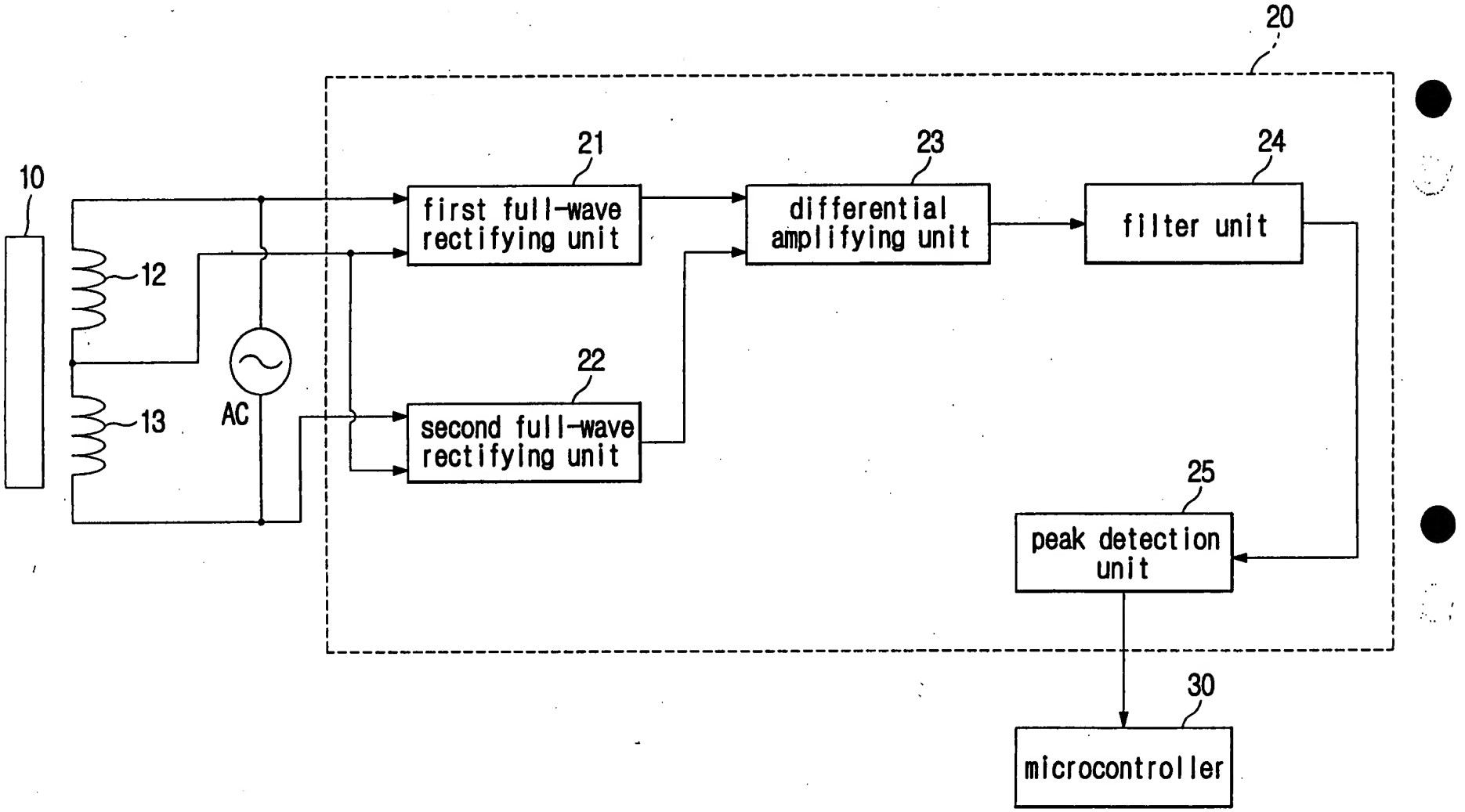

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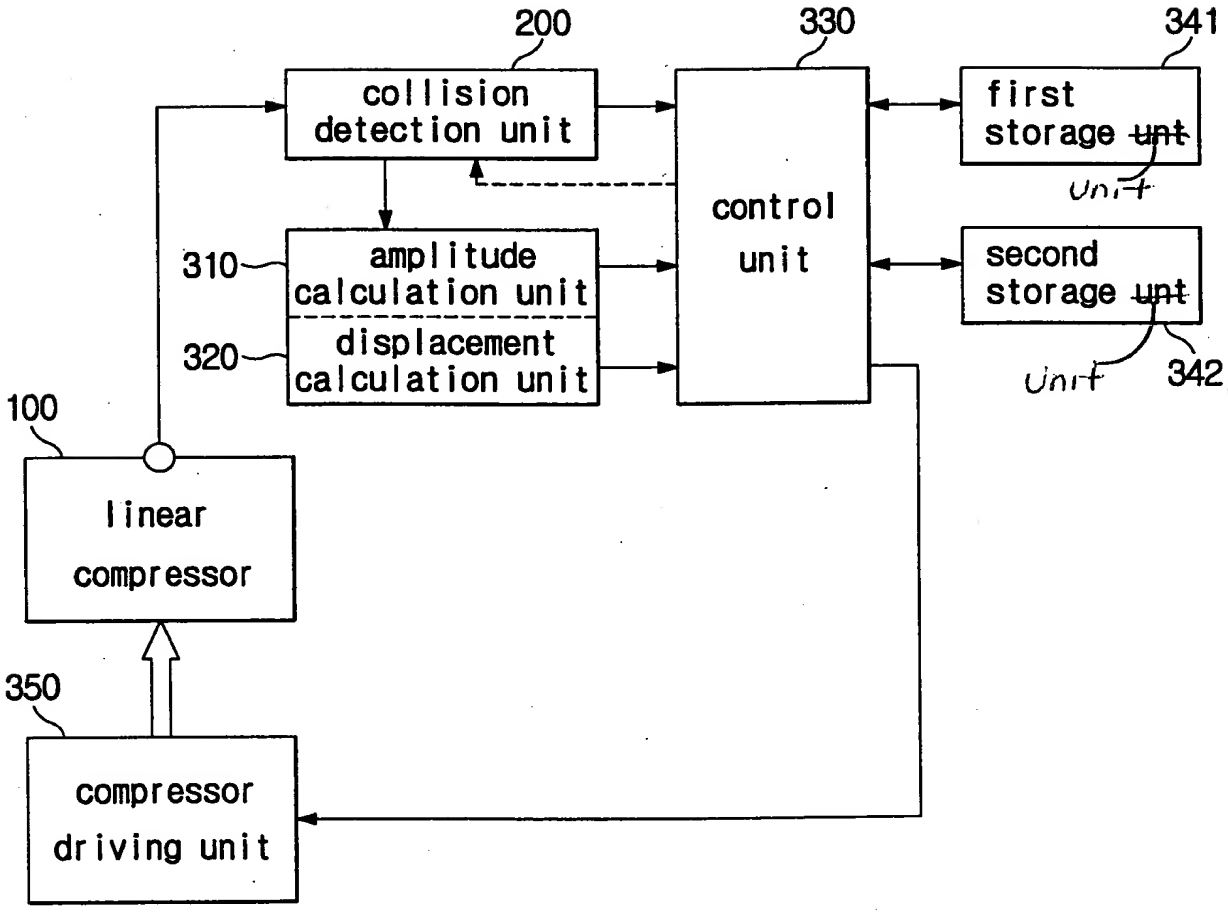
FIG. 2



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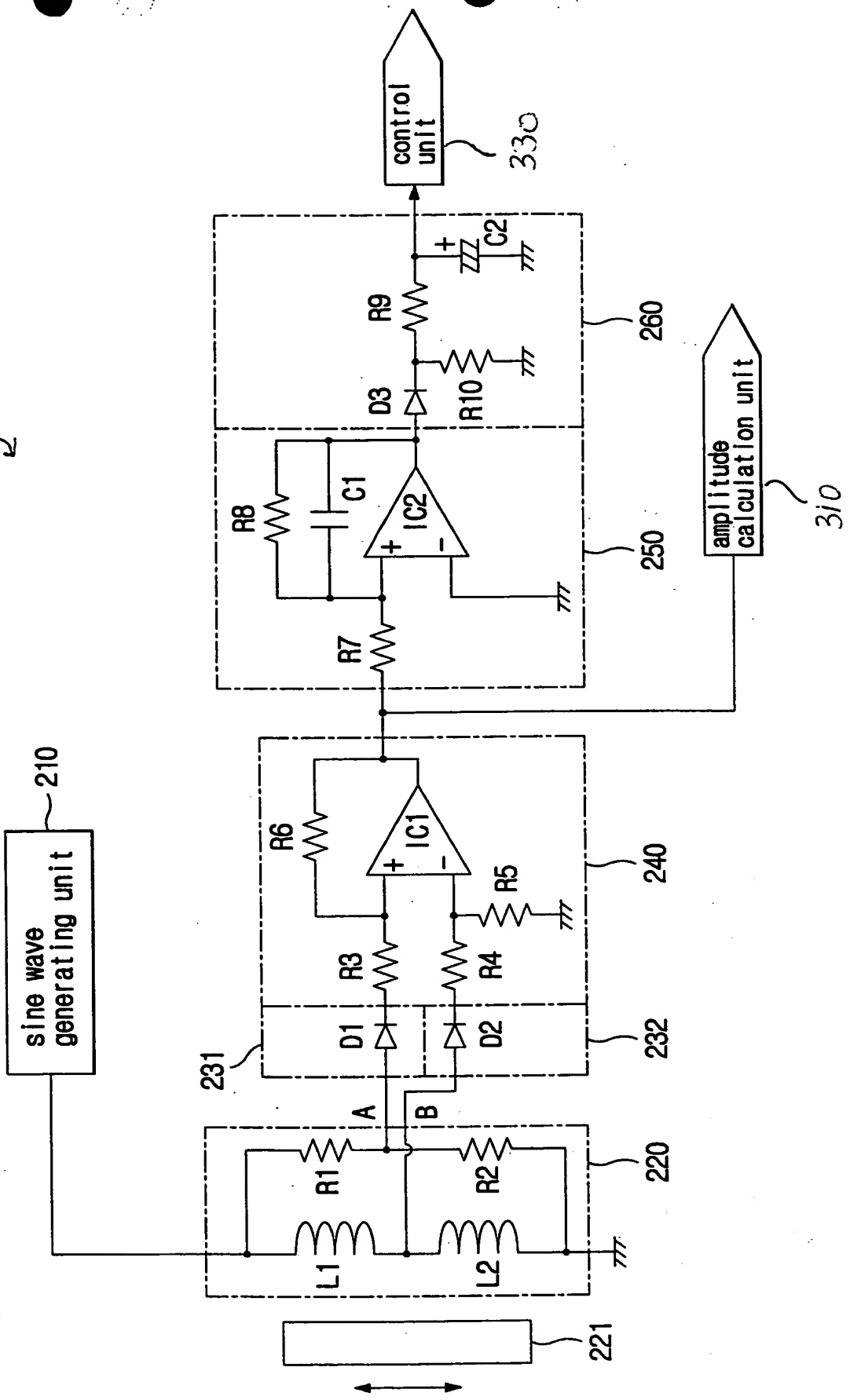
FIG. 3